



# Status of the Landsat Data Continuity Mission

**Del Jenstrom**

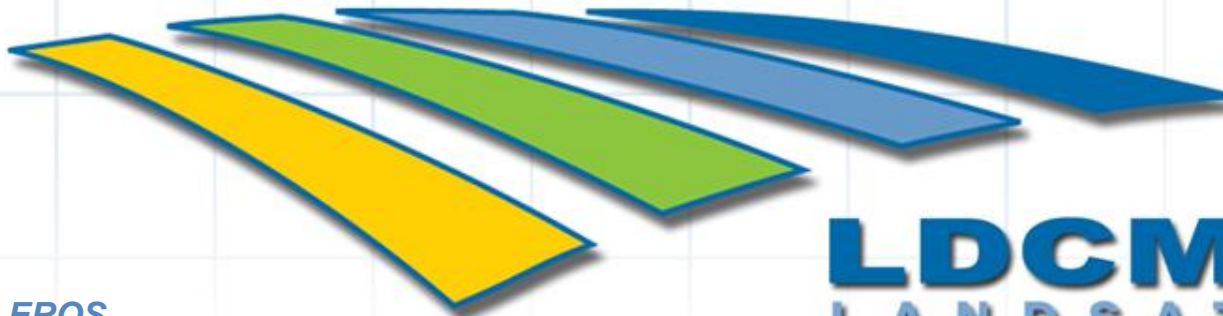
**LDCM Deputy Project Manager**

**NASA Goddard Space Flight Center**

**Landsat Science Team Meeting**

**Mesa, Arizona**

**March 1-3, 2011**



# LDCM Overview

## *Mission Objectives*

- Provide continuity in the multi-decadal Landsat land surface observations to study, predict, and understand the consequences of land surface dynamics
  - Land cover/use change
  - Human settlement and population
  - Ecosystem dynamics
  - Landscape scale carbon stocks
  - Resource management/societal needs

## *LDCM Data Needed to Address NASA Earth Science Focus Areas, Questions, and Applications*

<i>Focus Areas</i>	<i>Science Questions</i>
<ul style="list-style-type: none"><li>• Carbon Cycle, Ecosystems, &amp; Biogeochemistry</li><li>• Water &amp; Energy Cycle</li><li>• Earth Surface &amp; Interior</li></ul>	<ul style="list-style-type: none"><li>- What are the changes in global land cover and land use, and what are their causes?</li><li>- How do ecosystems, land cover &amp; biogeochemical cycle respond to and affect environmental change?</li><li>- What are the consequences of land cover and land use change for human societies and the sustainability of ecosystems ?</li><li>- What are the consequences of increased human activities on coastal regions?</li></ul>

## *Instruments*

- Operational Land Imager - BATC
- Thermal Infrared Sensor – GSFC

## *Spacecraft*

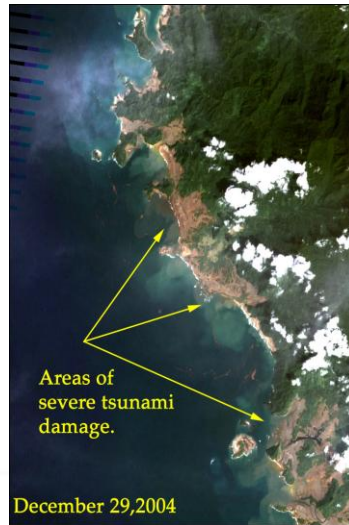
- Orbital Gilbert, AZ

## *Mission Team*

- NASA Goddard Space Flight Center
- Dept. of Interior's United States Geological Survey (USGS)
- NASA Kennedy Space Center



December 13, 2004

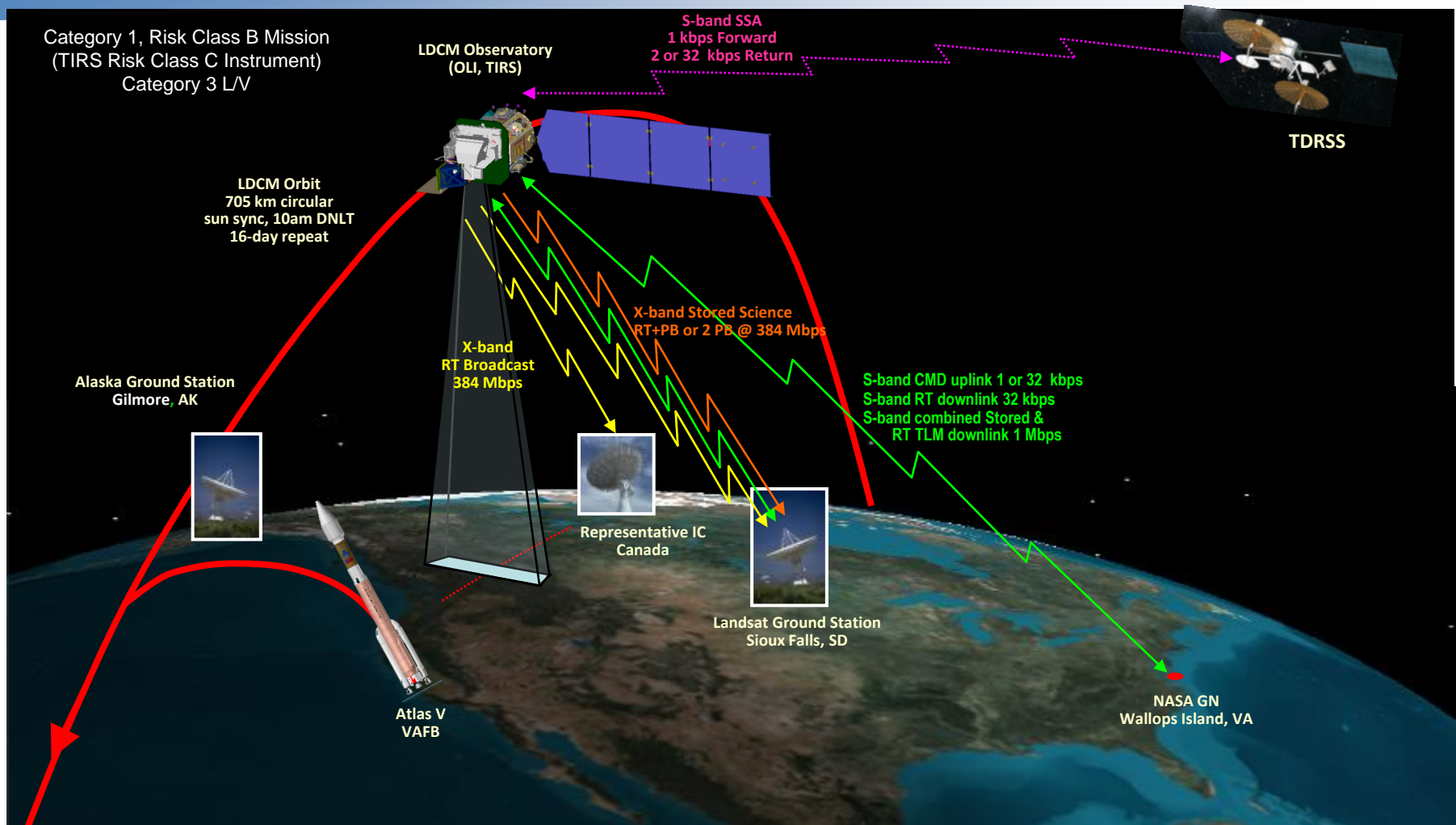


December 29, 2004

Landsat 7 data used to aid Indonesian government with tsunami relief efforts (David Skole, Michigan State University)

**LDCM**  
LANDSAT

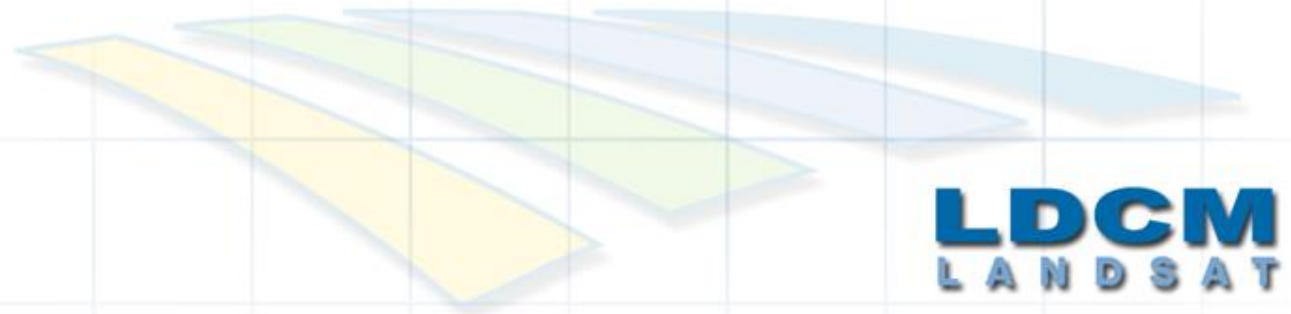
# Mission Overview



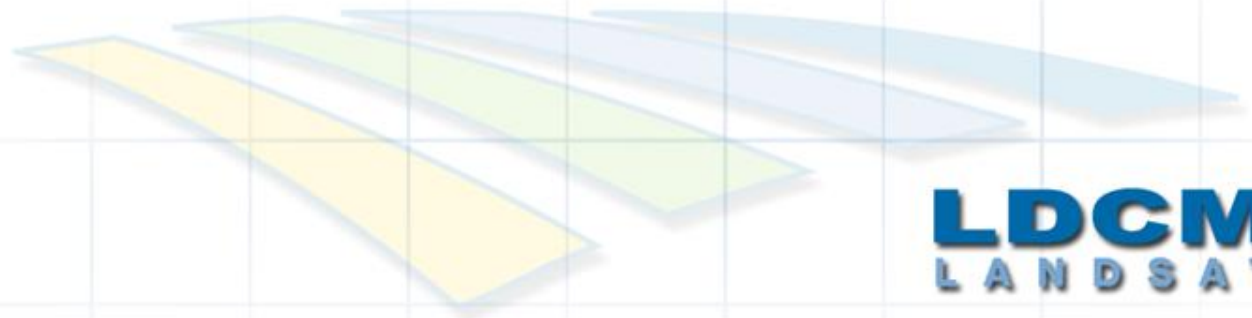
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# Agenda

- Project Status
- OLI Status
- TIRS Status (Covered separately)
- Spacecraft Bus Status
- Mission Operations Element & Operations Status
- Mission Risks
- Summary



# Project Status

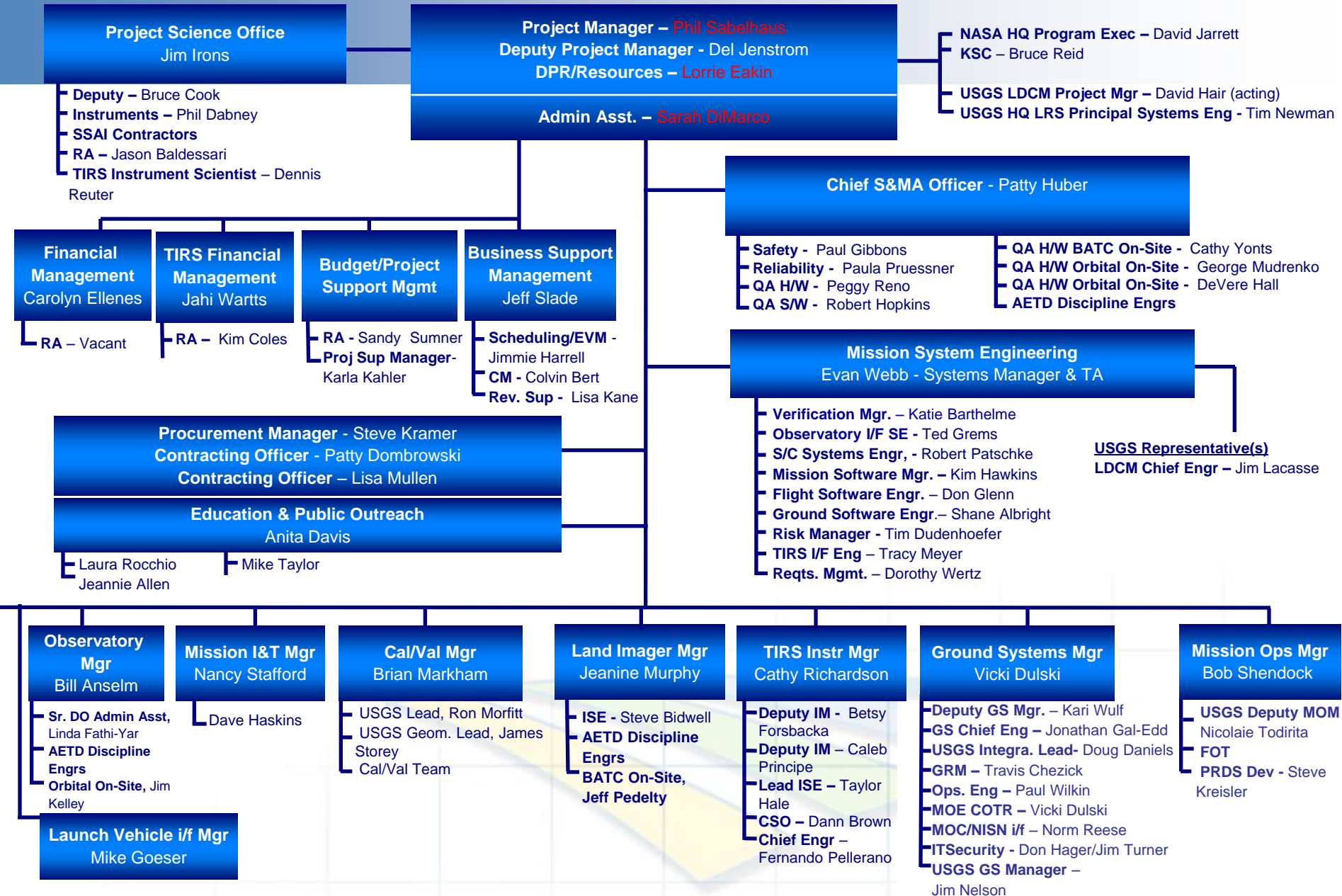


# Project Status

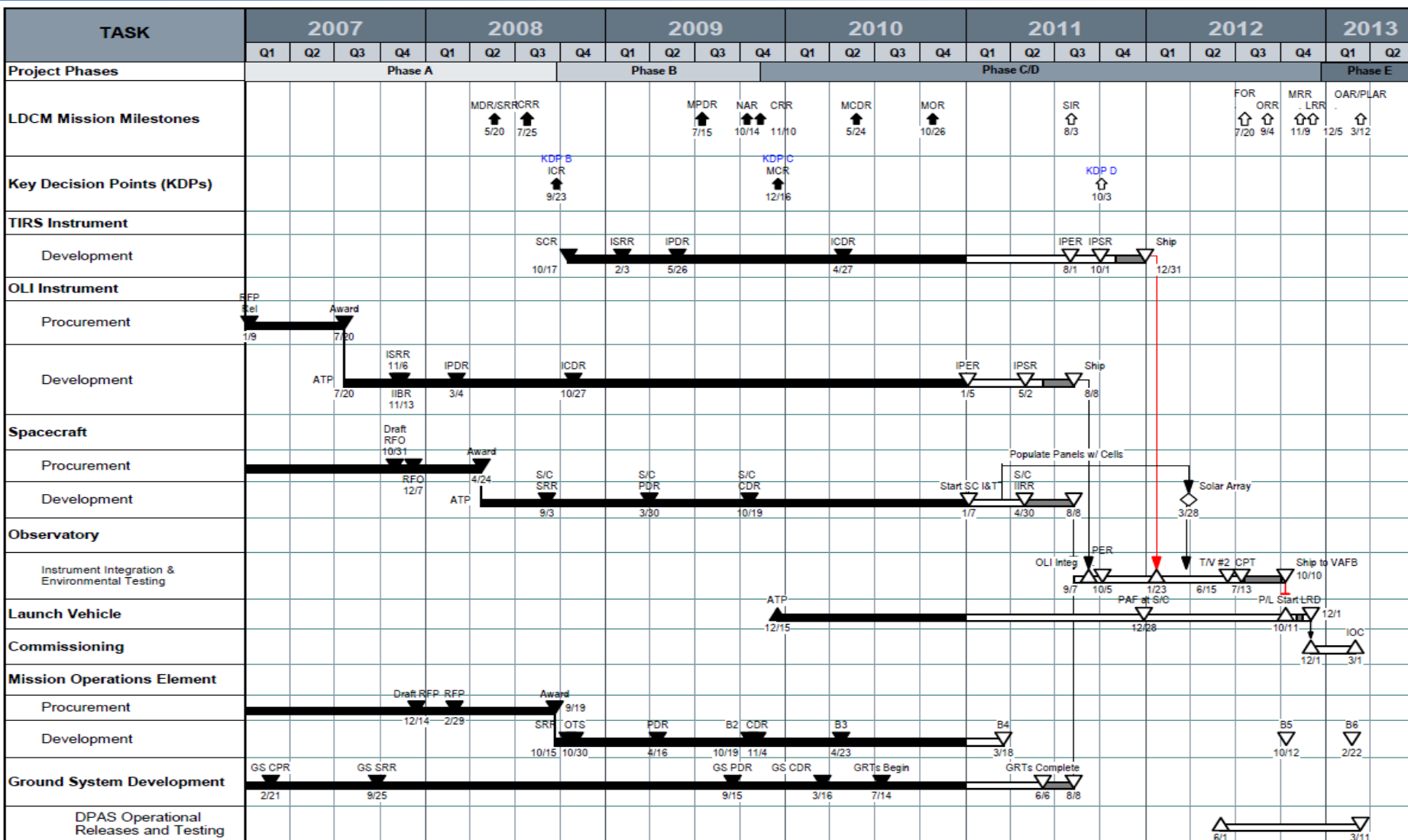
- General:
  - Bill Ochs has moved on to JWST
    - Other personnel changes have occurred as well
  - Reached agreement with NASA HQ on the release of additional reserves for FY11
  - Kick off meeting with launch vehicle team in September
    - A couple of new issues were discussed and are being worked
  - Launch Readiness Date (LRD) is December 1, 2012
- Reviews:
  - OLI PER held on January 5-6, 2011 at Ball
  - OLI PSR scheduled for late May 2011 at Ball
  - TIRS PER scheduled for August 2011 at GSFC
  - System Integration Review for August 2011 at GSFC



# LDCM - Project Organization

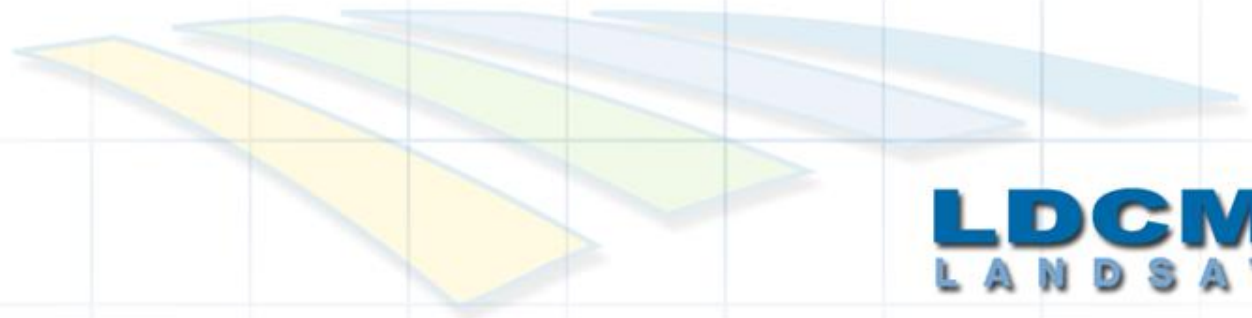


# LDCM Master Schedule



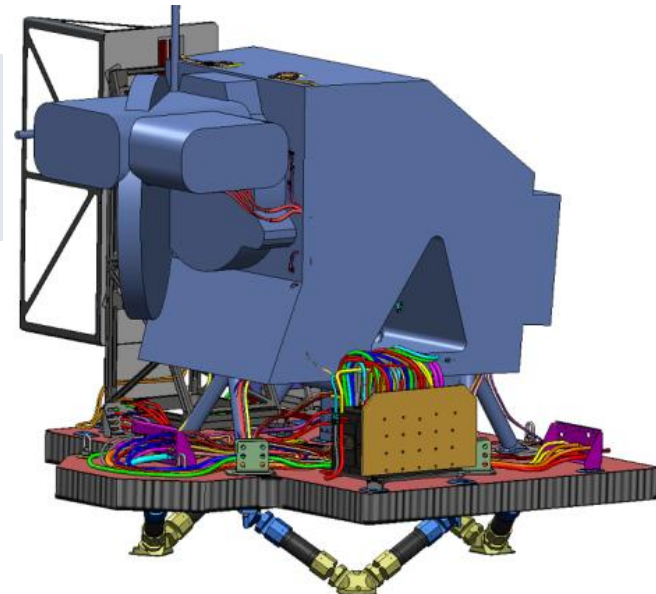


# OLI Status



## Accomplishments since June 2010

- Flight instrument completed
  - Focal Plane System
  - Calibration Subsystem
  - Electronics Boxes
  - Baseplate
- EDU configured OLI completed testing
  - EDU FPE, ISE, and FPA integrated with Flight Telescope
    - Spatial, spectral, and radiometric testing complete
- Flight OLI completed performance testing
  - Spatial, spectral, and radiometric testing complete
- Sensor integrated to baseplate



# Near Term Milestones (Next 6 months)

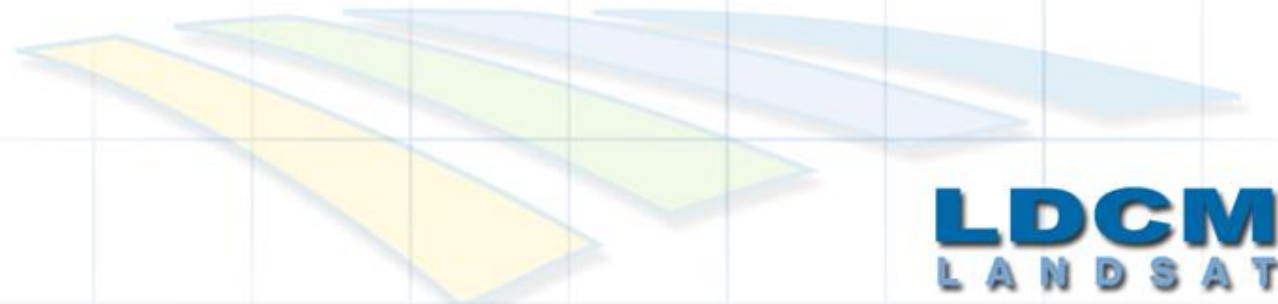
- Complete integration of OLI sensor to baseplate
- Complete environmental testing
  - EMI/EMC
  - Vibration
  - Thermal vacuum/thermal balance
- Ship OLI to the spacecraft vendor
- OLI Pre-Ship Review will be held ~2 weeks prior to shipment

# OLI Schedule

ID	Name	Duration	Start	Finish																								
					Feb '11				Mar '11				Apr '11				May '11				Jun '11							
					23	30	6	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19		
1555	Instrument Closeout Operations	18 d	1/29/11	2/18/11																								
1565	Configure OLI Assembly	14 d	2/19/11	3/7/11																								
1566	Remove Flight ISE Box	1 d	1/31/11	1/31/11																								
1567	Regression Test Flight ISE Box	28 d	2/1/11	3/4/11																								
1568	Reinstall Flight ISE Box	3 d	3/5/11	3/7/11																								
1569	FPA Alignment Check (Pre-EMC/EMI and Vibe)	1 d	3/8/11	3/8/11																								
1570	Instrument Functional Test	4 d	3/9/11	3/12/11																								
1571	EMI/EMC Test	17 d	3/14/11	4/1/11																								
1572	OLI Assembly 3-Axis Vibration Test	9 d	4/2/11	4/12/11																								
1573	Instrument Functional Test	3 d	4/13/11	4/15/11																								
1574	FPA Alignment Check (Post-EMC/EMI and Vibe)	1 d	4/16/11	4/16/11																								
1575	Thermal Vacuum/Thermal Balance Testing	33 d	4/17/11	5/19/11																								
1576	TQCM Outgass Mmeasurement	3 d	5/20/11	5/24/11																								
1577	Instrument Functional Test and Mass/CG	5 d	5/25/11	5/31/11																								
1579	Instrument Close-Out Operations	7 d	6/1/11	6/8/11																								
1580	Pack Instrument	6 d	6/9/11	6/15/11																								
1581	Instrument Performance Testing Data Analysis	0 d	6/15/11	6/15/11																								

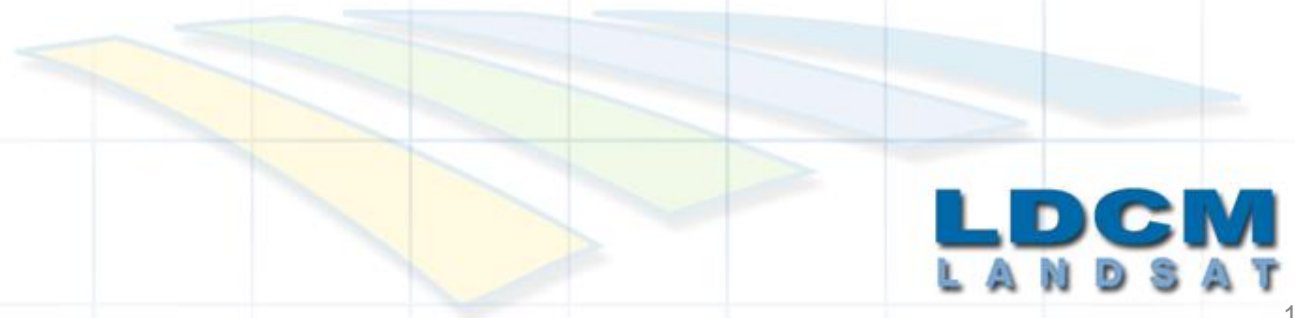
# OLI Issues

- Focus Mechanism Motors (Closed)
  - New motors fabricated, assembled, and installed with no further issues
- Aeroflex SRAM (memory devices) Reliability (Closed)
  - New parts received from Aeroflex were installed and successfully tested
- Resonant tank circuit in survival heater power supply
  - Stressed voltage regulator parts were replaced
  - Resistors added to the base of the linear regulator circuit to stabilize the circuit
  - The ISE Box successfully completed EMI/EMC, vibration, and thermal cycling regression testing
  - Integration of the ISE to the OLI will be completed during OLI Assembly

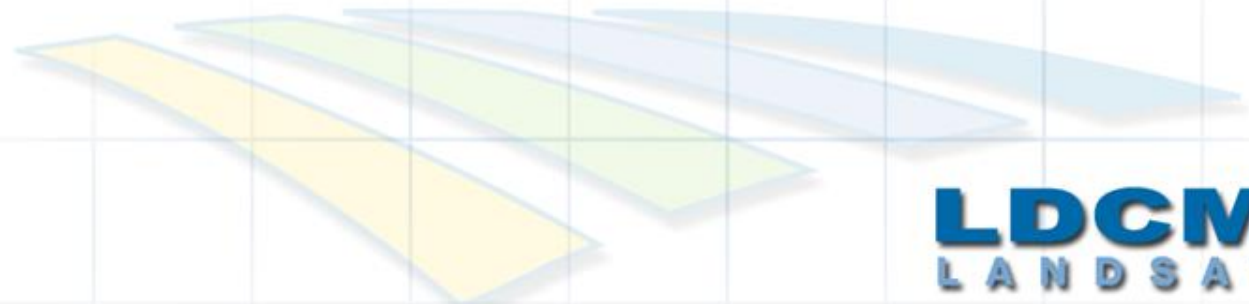


# TIRS Status

Betsy will provide separately



# Spacecraft Bus Status





# Accomplishments Since June 2010

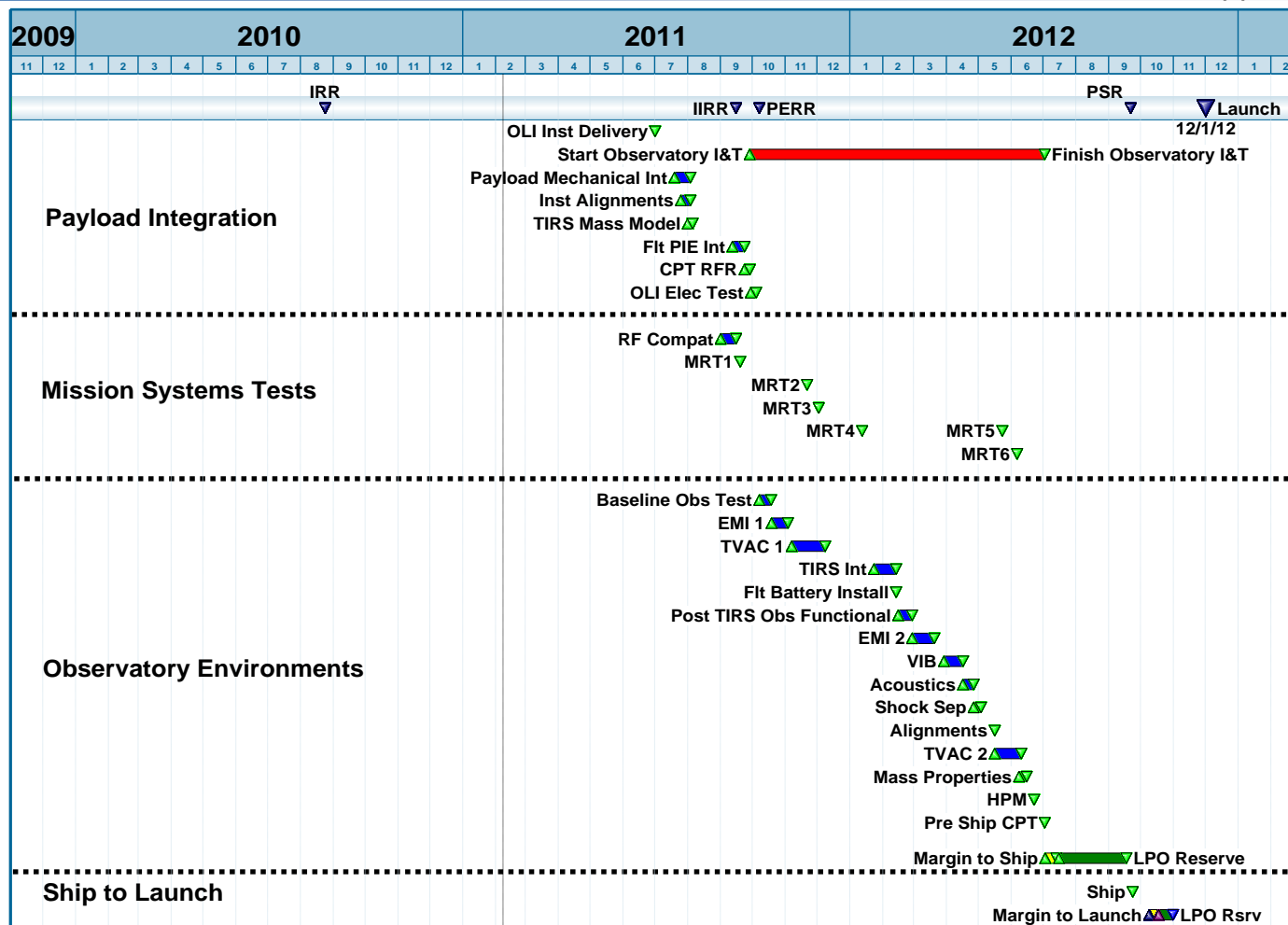
- Spacecraft bus I&T underway
  - Initial power on the bus in late January
  - Flight oven controlled crystal oscillator, the advanced multi-mode (S-Band) transceiver, the Caribou decryptor and harness interface box have successfully been integrated
  - Attitude control sensors and actuators (including RWA's) are currently being integrated
- All Engineering Model (EM) avionics boxes complete and tested
- Flight avionics boxes in test
- EM solar array deployed
- Spacecraft primary structure assembly complete
  - Structural testing on-going
- OLI Interface Simulator tested with S/C Interface Simulator
- Flight Battery cells activated

# Near Term Milestones Next 6 months

- Spacecraft
  - Complete integration of all flight boxes
  - Benchmark Comprehensive Performance Test (CPT)
- Deliverables:
  - Spacecraft Interface Simulator (SIS)
  - Spacecraft/Observatory Simulator (S/OS)
- Milestones
  - Spacecraft Test Readiness Review (i.e., Spacecraft Complete)
  - Instrument Integration Readiness Review (for OLI)
- Analyses and Tasks
  - Jitter and Line Of Sight stability
  - STOP analysis
  - Execute Mission Readiness Tests with the MOC

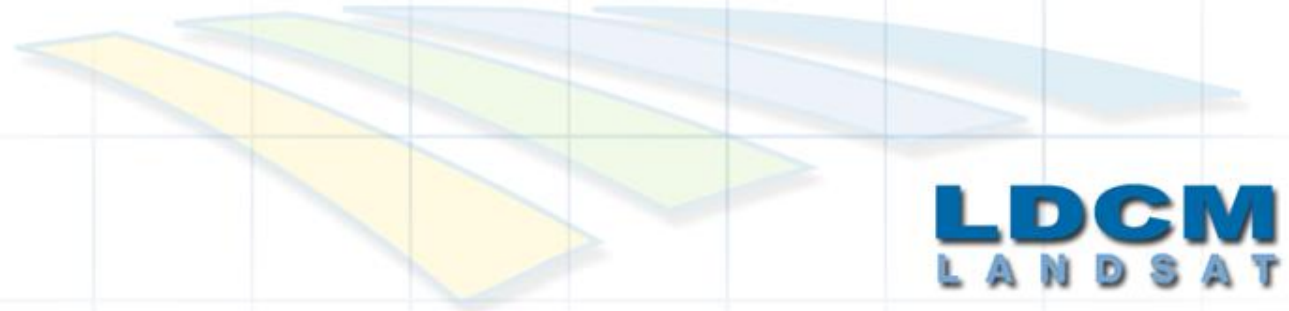
# Spacecraft Bus Schedule

2/7/11



# Spacecraft Issues Closed

- Solid State Recorder (SSR) Memory Error
  - New devices fully qualified, installed, and tested
  - Flight recorder to deliver this month
- S/C Instrument Deck Delamination
  - De-laminations repaired, qualified, delivered, and integrated
- GPS EEE Parts
  - Possibly overlooked failed DPA – document showed okay
- RWA contaminated lubricant
  - Disassembled, re-lubed, qualified, delivered, integrate this week

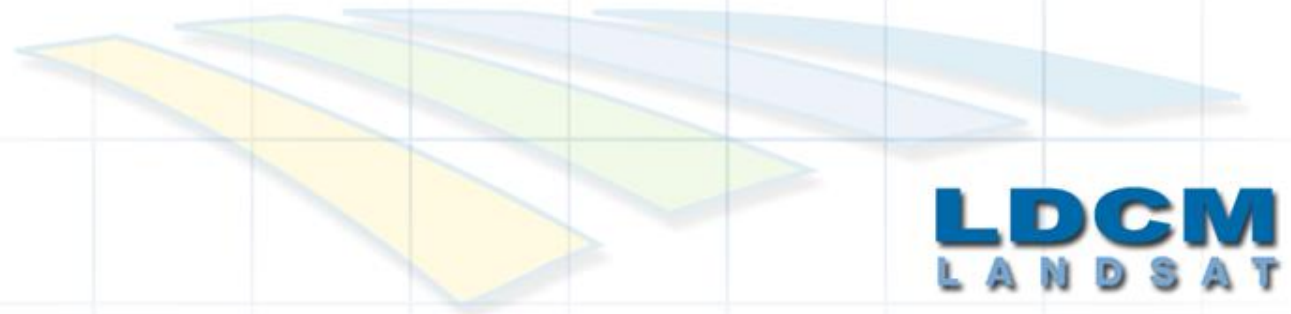


# Spacecraft Issues Open

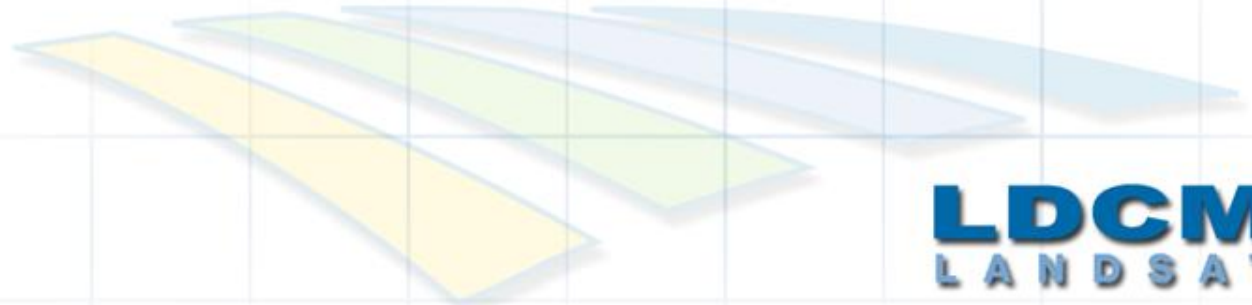
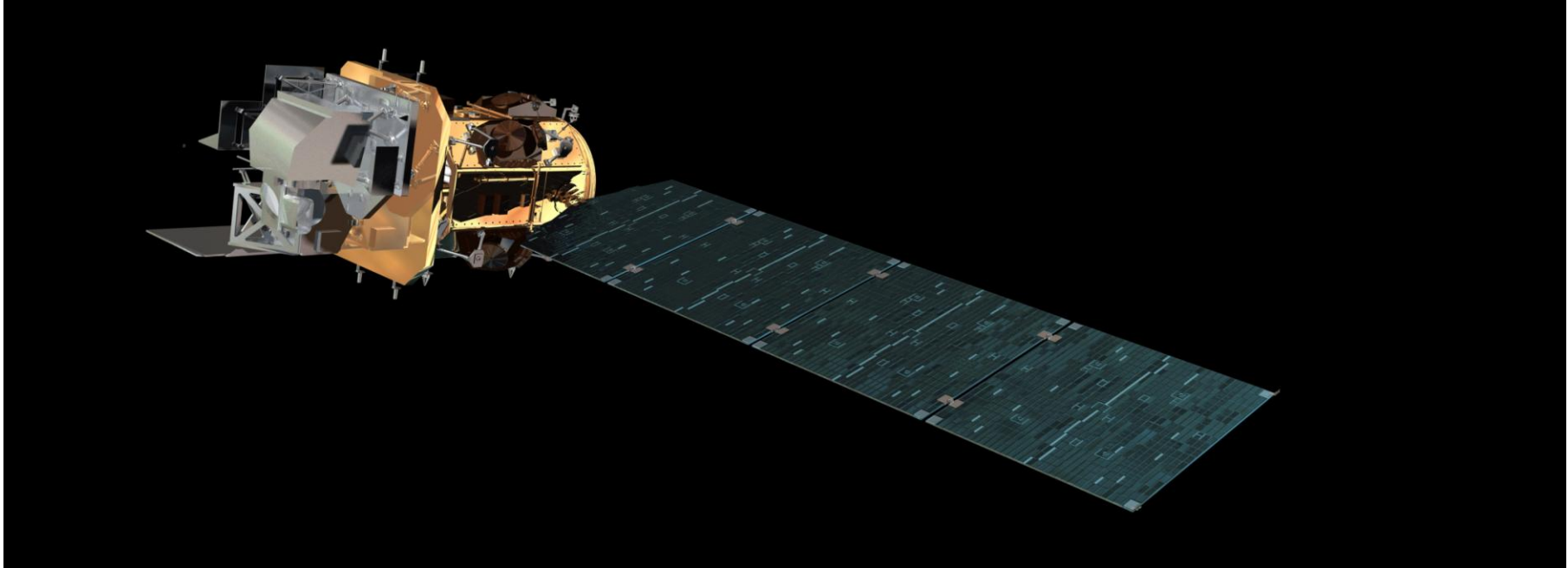
- Star Tracker Assembly (Goodrich)
  - Focal Plane Array shifted after vibe and after TVAC
  - Assembly process had changed; corrective actions ineffective to date
  - Non-LDCM sensor head with old processes now in pathfinder qual
  - Initial results look good; EM available now; Flight units ~August
- Payload Interface Electronics (GDAIS)
  - Production delays at General Dynamics
  - FPGA coding errors uncovered – “deep dive” underway
  - EMs on hand; Flight unit available in September/October
- Transmit Crystal Oscillator
  - Failed lead-pull test
  - New lot cleaned, rebuilt, 100% tested, qual test, life test and accepted
  - One lead failed pull test
  - X-Band TX on hold until resolved – could be over test; could be weak part

# Spacecraft Issues Open

- S/C Solar Array Substrate Delamination (MDA)
  - Delaminations analyzed and repaired
  - Delaminations again occurred on qual (not flight) panel around cup/cone
    - Investigation underway
    - Errors found in as built qual panel; other repair options are being analyzed and will be tested as well
    - Schedule work arounds are being explored
- Space Inertial Reference Unit (SIRU) Northrup Gruman
  - Two gyros (HRGs) were replaced due to out of family scale factor drift after environmental testing
  - One of the two replaced HRGs is once again showing high scale factor drift and will probably need to be replaced
  - Root cause is unknown at this time



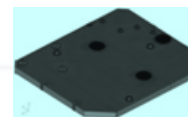
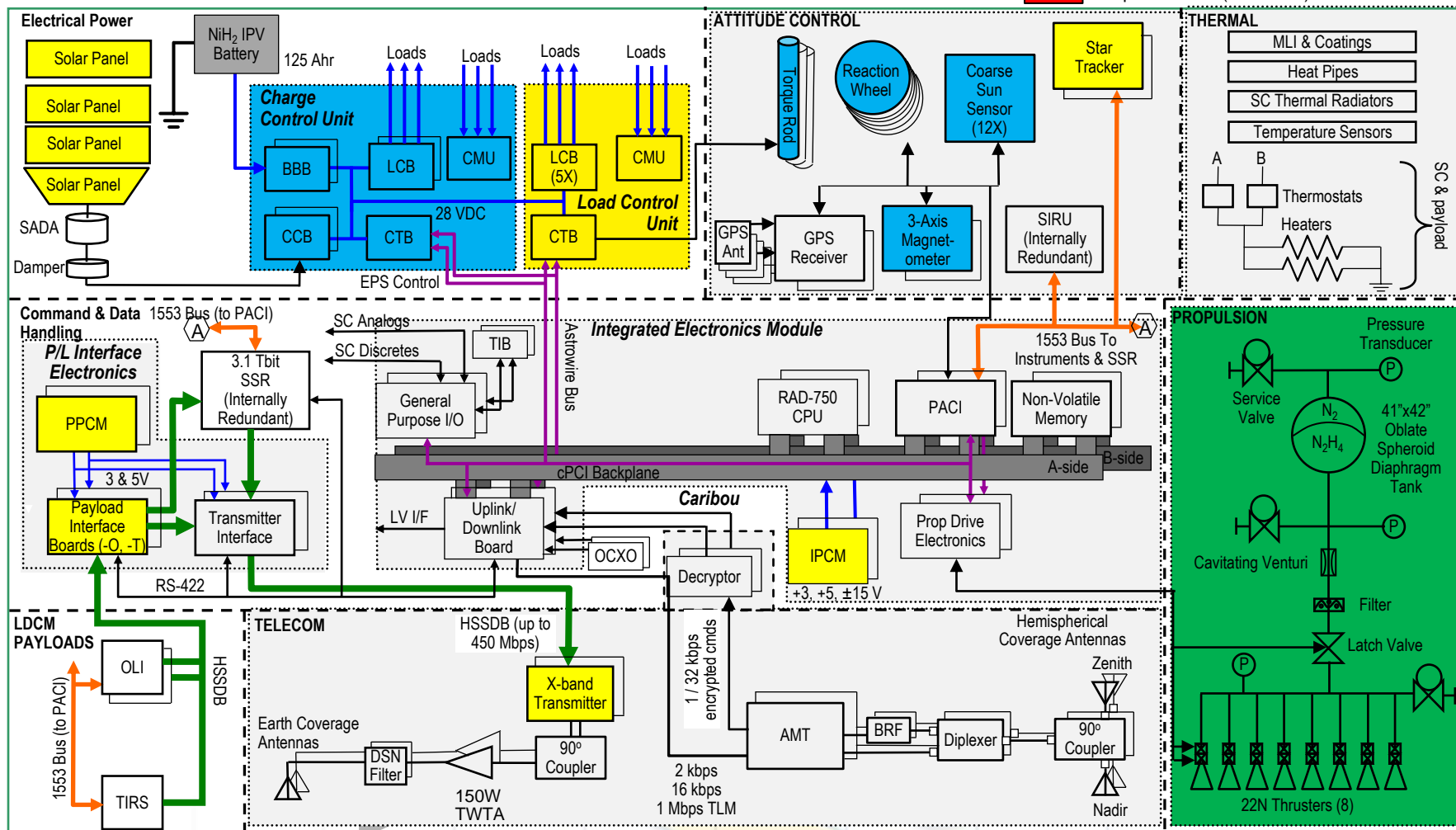
# Spacecraft Build Status



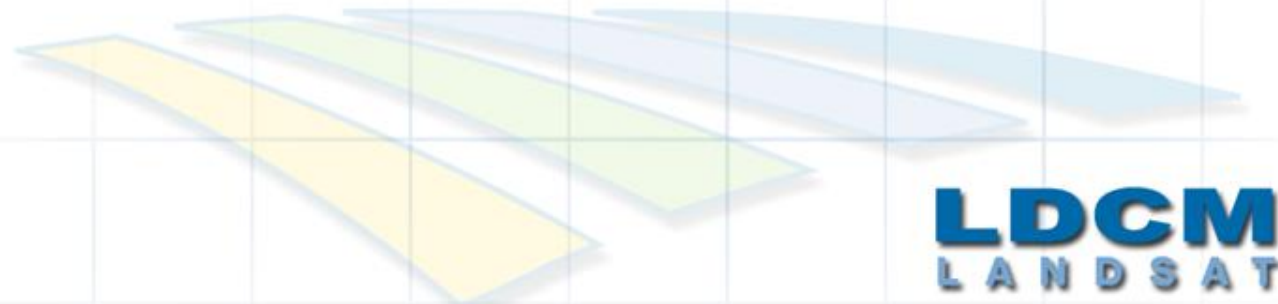


# SPACECRAFT FLIGHT BUILD

- Not Begun
- Design Complete
- In Fabrication/On Order
- Fab Complete/Received
- Integrated, Not Tested
- Integrated & Tested
- Anomaly Under Investigation
- Repair/Rework (see notes)



# MOE & Operations Status



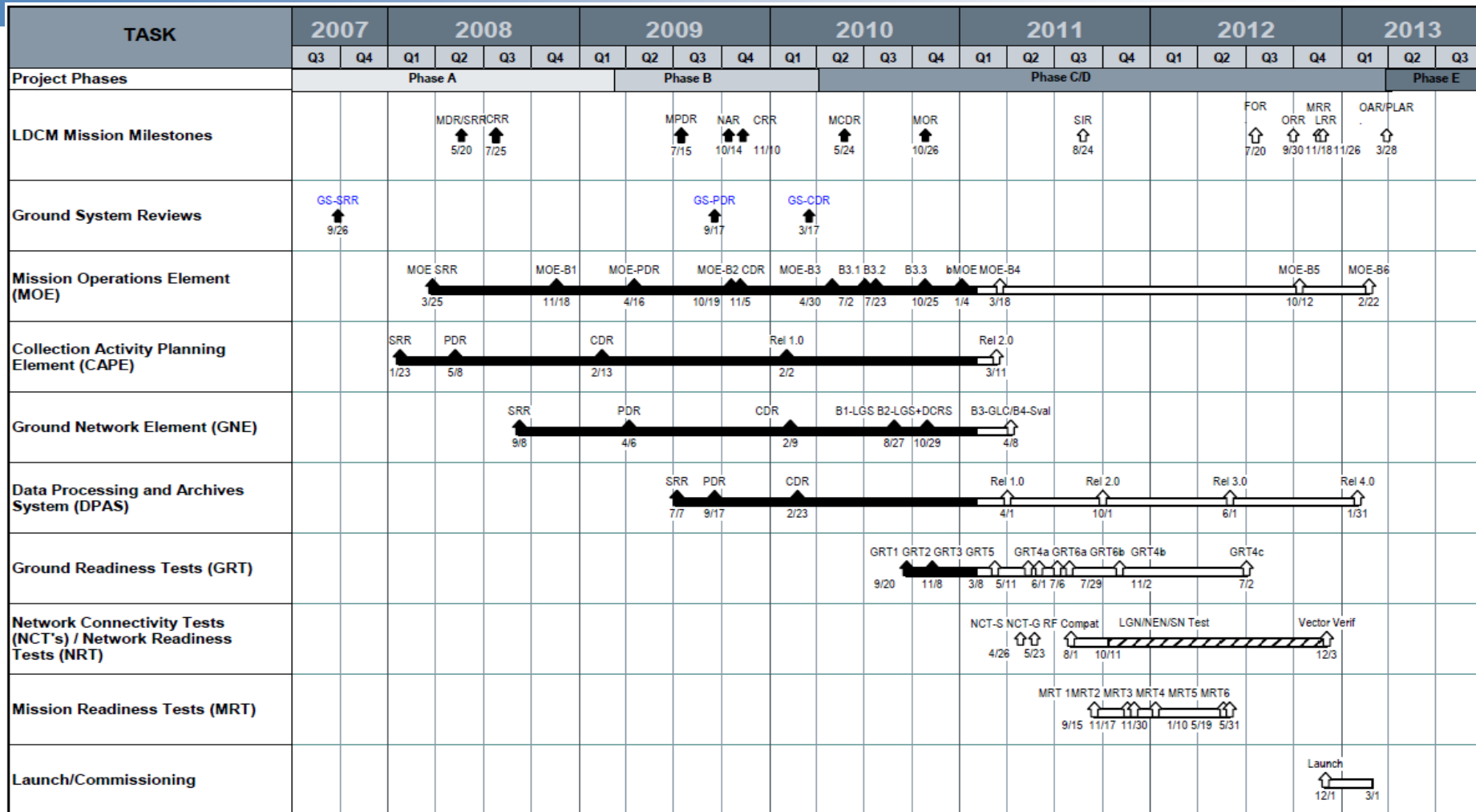
# Accomplishments Since June 2010

- Formal Ground Readiness Tests (GRTs) began in July 2010 and are on-going
  - GRT 1 (July-Sept. 2010)
    - Tested command and telemetry functions between MOC and EROS ground station
  - GRT 2 (Nov. – Dec. 2010)
    - Tested planning and scheduling and mission data management functions across MOC and EROS ground station
    - Included testing with Orbital high-fidelity spacecraft/observatory simulator (SOS)
  - GRT 3 (March 2010)
    - Preparations and dry-runs are nearing completion
    - Will test flight dynamics functions within MOC
- Backup MOC facility has been stood up at GSFC, Building 32 (sharing Landsat 7 MOC space)
  - bMOE and bCAPE are installed and failover and conops checks are underway
- Successfully tested interfaces between MOC and SOS, SDVF, and S/C command decryptor
- Established a “listen line” from S/C I&T facility back to MOC to view and monitor telemetry collected during I&T
- 12 full-time FOT on staff
- Mission Operations Review successfully conducted in October 2010
- Svalbard, Norway ground station progress
  - Completed installation and integration of LDCM-specific equipment
  - Level 5 testing is underway
- Additional GS development status to be covered in USGS LDCM status

## Near Term Milestones (Next 6 months)

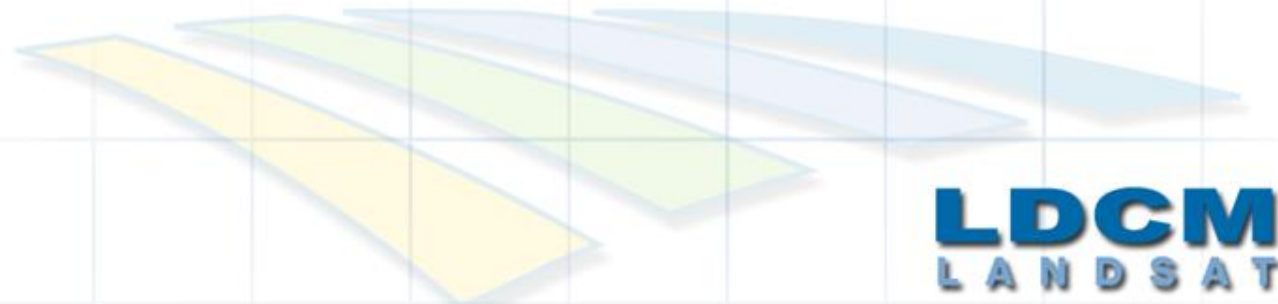
Milestone	Planned Date
CAPE Build 2.0	March 2011
MOE Build 4.0	April 2011
DPAS Build 1.0	April 2011
Svalbard and GLC station-MOC tests	April – May 2011
GRT 4a (safeguard mission data)	May 2011
GRT 5 (GS failover and contingencies)	May-June 2011
GRT 6 (MOC capstone and automation)	July 2011
RF compatibility testing	August 2011

# GS Schedule

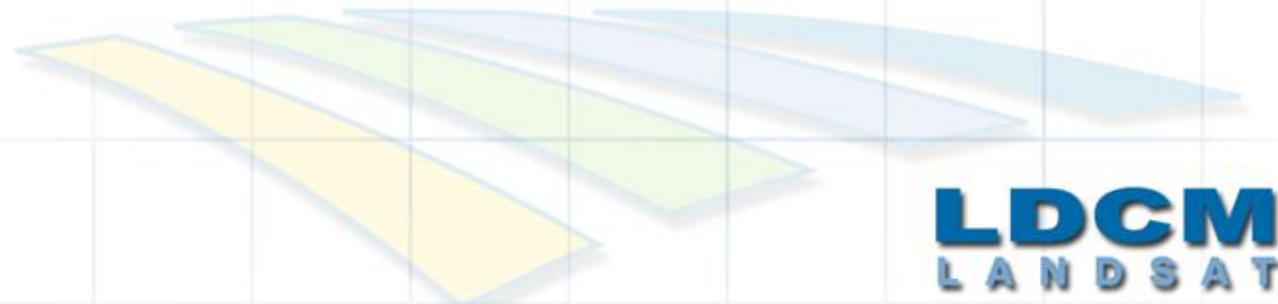


# GS Issues

- GS Access to Hotbench and SOS - Given that the Ground's access to the hotbench and SOS is subject to changes in the spacecraft I&T and SOS development schedules; there is a possibility that the GRTs will lose fidelity and/or GRT schedule will slip.
  - GS has mitigated this risk by using other simulator resources and negotiating remote access to the S/OS while at Orbital
  - Current delivery date of April/May may cause schedule slip to GRTs 5 and 6
    - GS in process of evaluating whether to conduct GRT 5 remotely or after S/OS shipment and installation in MOC
- TIRS Simulator (TS) delay - Given that the TIRS Simulator (TS) will be delivered late for integration to the SOS; there is a possibility that this will further delay the delivery of the SOS to the MOC and will impact the GRT completion schedule.
  - TS delivery currently estimate to be near end of calendar 2011
  - GS currently evaluating impacts and options for GS testing

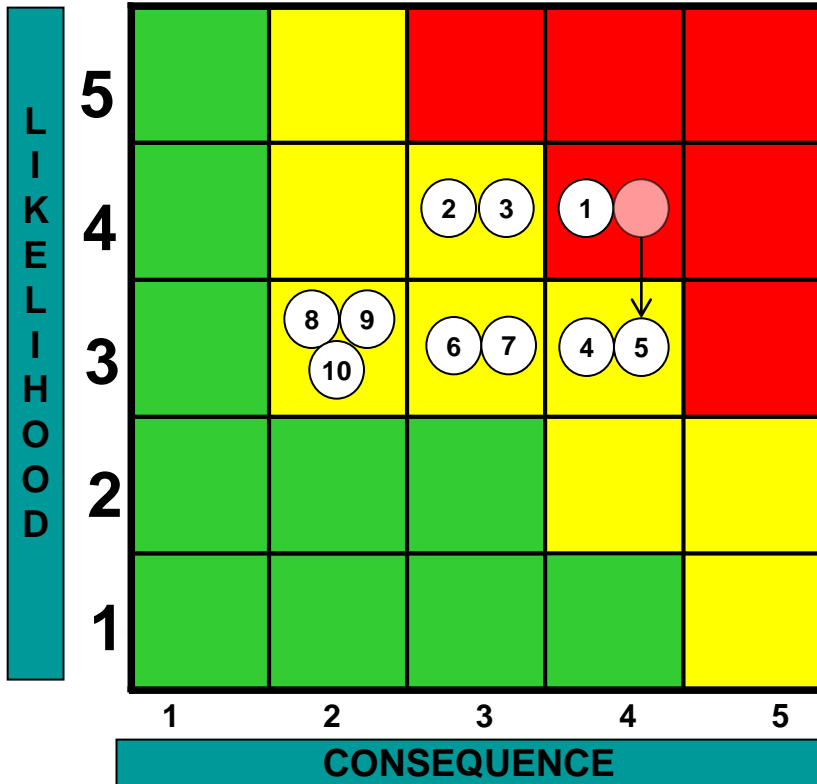


# Mission Risks and Summary

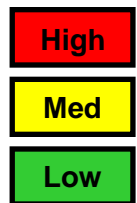




# LDCM Top Risks



## Criticality



## Approach

M - Mitigate  
W - Watch  
A - Accept  
R - Research



## L x C Trend

Decreasing  
(improving) Increasing  
(worsening)  
Unchanged  
New since last month

L*C Trend	Risk ID	Approach	Risk Title
<b>LDCM RISKS</b>			
➡1	PM-71	M	TIRS Schedule
➡2	PM-55	M	Observatory Jitter
➡3	PM-86	M	SIRU Delivery Delays
4*	PM-95	M	Centaur ESD
↓5	PM-90	M	Water-soluble Flux in Industry
➡6	PM-97	M	S/C LV Acoustic Loads
7*	PM-96	M	Spacecraft Harness Particulates
➡8	PM-89	M	SA Deployment Rate Check
➡9	PM-88	M	TIRS Simulator Delay
➡10	PM-75	M	GS Access to Hotbench and SOS

# Project Summary

- Launch Readiness Date is December 1, 2012 with 3 months of schedule slack
  - In addition, we have flexibility in the observatory risk reduction testing scheduled for this fall
- OLI has completed I&T and has started environmental testing
  - Delivery to Orbital planned for June 2011
  - It's a very good performing sensor
- TIRS has started I&T
  - Current delivery date is November 2011
- Spacecraft bus has started I&T
  - Concerned about issues with late deliveries of flight components
  - Evaluating workarounds to accommodate late the deliveries
- Ground System continues to make good progress